LA-UR-11-10994
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Title: Catalyzed Conversion of Non-Food Biomass Using Algal Lipids and Carbohydrates.

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Intended for: DOE
First International Conference on Algal Biomass, Biofuels, and Bioproducts, 2011-07-17/2011-07-20 (St. Louis, Missouri, United States)
Poster
Biological resources
Reading Room
RCRA

Catalyzed Conversion of Non-Food Biomass Using Algal Lipids and Carbohydrates.

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Introduction

Biomass, if efficiently converted to high energy density fuel, has the potential to become a sustainable source of this commodity, instead of petroleum. Examples of useful biomass include corn stover, switch grass, wood chips, and grass clippings. Efficient conversion of biomass into fuel could account for 100% of US petroleum imports. This poster will describe our efforts in the conversion of algal products to fuel and useful higher value commodities and the use of catalysis for the conversion of biomass to fuels.

In order for biomass to become a viable fuel source, an efficient process for its conversion into hydrocarbons (i.e. fuel) must be developed. This conversion process has four steps. First, the cellulosic sugars must be extracted from the biomass source. Next, the carbohydrates undergo a carbon chain extension reaction. The cellulosic starting materials are either five or six carbons in length whereas high-energy density fuels are eight to fifteen carbons in length. This carbon chain extension reaction makes the polyols the proper length for a fuel. This step is often done using an aldol condensation reaction. Finally, the aldol products are deoxygenated and then hydrogenated in order to yield a hydrocarbon that can be burned as a high-energy density fuel.

Algal biomass is attractive since one of it’s major sources of carbon is from carbon dioxide and many species are tolerant of brackish environments. This poster will describe our efforts to take algal lipids and converting those to deoxygenated hydrocarbons. In addition, the algal carbohydrates are also attractive for conversion to furan based molecules which are used in fuel production.

NAABB and NABC Organizations and Goals

National Alliance For Advanced Biofuels and Bio-products

Consortium Lead:
The Donald Danforth Plant Science Center (DAN)

Participants/Partners:

Los Alamos National Laboratory (LANL)
Pacific Northwest National Laboratory (PNNL)
University of Arizona (UA)
Brooklyn College (BC)
Colorado State University (CSU)
New Mexico State University (NMSU)
Texas AgriLife Research -Texas A&M University System (TAMU)
University of California Los Angeles (UCLA)
University of California San Diego (UCSD)
University of Washington (UW)
Washington University in St. Louis (WUSL)
Washington State University (WSU)

AXI (AXI)
Catilin (CAT)
Diversified Energy (DE)
Eldorado Biofuels (EB)
Genifuel (GEN)
HR BioPetroleum (HRBP)
Inventure (INV)
Kai BioEnergy (KAI)
Palmer Labs (PAL)
Solix Biofuels (SOL)
Targeted Growth (TGI)
Terrabon (TER)
UOP (UOP)

NABC National Advanced Biofuels Consortium

Biofuels for Advancing America

National Advanced Biofuels Consortium

Consortium Leads

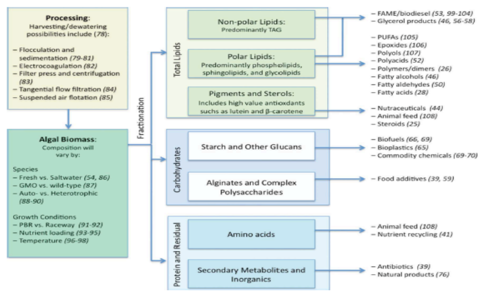
National Renewable Energy Laboratory
Pacific Northwest National Laboratory

Consortium Partners

Albemarle Corporation
Amyris Biotechnologies
Argonne National Laboratory
BP Products North America Inc.
Catchlight Energy, LLC
Colorado School of Mines
Iowa State University
Los Alamos National Laboratory

Pall Corporation
RTI International
Tesoro Companies Inc.
University of California, Davis
UOP, LLC
Virent Energy Systems
Washington State University

Conversion Products from Algae



LANL Biomass to Fuels Capabilities

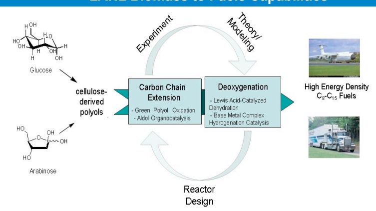


Figure 2. Process for converting biomass into high energy density fuel. This project focused on the carbon chain extension step of this process.

Non-food based sources
agricultural residues (*e.g.* corn stover), dedicated energy crops,
wood residues (e.g. paper mill discards), municipal paper waste

Using Organocatalysis: carbon chain extensions to give C9 and C15 Carbon Chains (LANL LDRD)

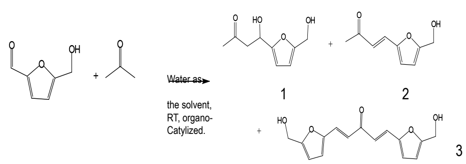
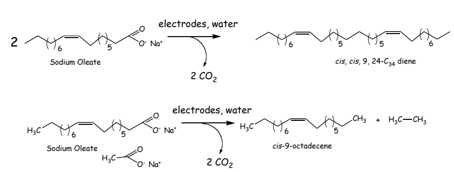


Table 1.

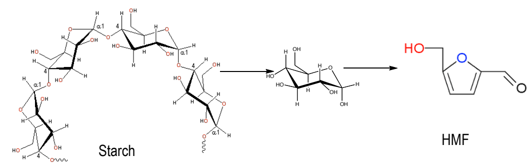
Catalyst	Yield
Piperidine	61% (2)
1-methylpiperizine	70% (1) + 30% (2)
(S)-2-Hydroxymethyl piperizine	53% (2)
(R)-2-Hydroxymethyl piperizine	46% (2)

Biomass Conversion: Algal Fatty Acids Kolbe Coupling (NAABB)



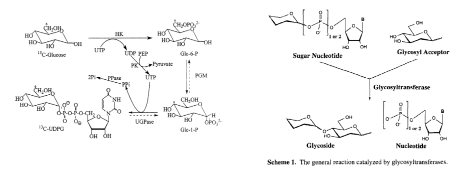
Yields have been good to excellent. Olefins do not appear to affect reaction course. Next steps will be to examine methods for direct conversion of triglycerides to hydrocarbons.

Direct Conversion of Algal Starch to Higher Value Products (NAABB)



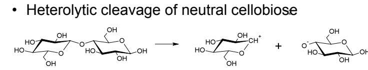
Process uses lanthanides triflates and halides in water. Microwave promoted. Currently evaluating conversion precentages.

Synthesis of Site Specifically Stable Isotope Labeled (^2H and/or ^{13}C) Oligosaccharides for Mechanistic Pyrolysis Studies (NABC)

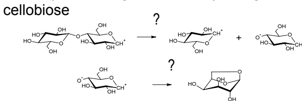


Model Reactions

- Heterolytic cleavage of neutral cellobiose



- Heterolytic cleavage of positively charged cellobiose



Goal: Understanding pyrolysis mechanisms could give rise to Optimized conversion condictions.

Conclusion

It is believed that biomass can be converted to transportation fuels through carbon chain addition. It is proven that through aldol reactions of biomass these carbon additions are possible. Further tests are needed to show that hydrodeoxygenation can be accomplished under economical conditions.

Biomass derived from algal has been demonstrated to be converted to low oxygen content high energy density hydrocarbons. Current efforts to determine the cost of inputs in the Kolbe reaction will determine if this is an economical viable pathway to these fuels.

Stable isotope labels will be usefull in sorting out the chemiical / processes/steps in pyrolysis of lignocellulosic materials.

Acknowledgements

We thank the DOE EERE NAABB & NABC and LANL for LDRD DR and ER support for this work.